becoming horizontal. The first condition, therefore, which is supposed to give rise to zygomorphy is that the flower must be large enough to offer some part of it as a landing to the insect.

If one wished to understand the most important characters of zygomorphic flowers he might ask this question: How did some flowers come to be sternotribe with nectaries on the upper side, and others nototribe with nectaries on the lower side? These peculiarities seem to have depended on what part of the flower originally offered a landing to the insect. Insects seem to prefer the stamens and styles as a lighting place, and to have used them as such in all cases except those in which these parts were concealed in a tube. This may be because these organs were most horizontal, or came in the way of the lower petals, and because the pollen which they bear is often the object of the visit.

According as the original characters of the flowers are supposed to favor the development of sternotribe or nototribe zygomorphy, we will consider flowers in two divisions: 1. Polypetalous (including monocotyledons), shallow gamopetalous and deep gamopetalous flowers with exserted stamens and styles. 2. Deep gamopetalous flowers with included organs.

Carlinville, Ills.

Notes on structures adapted to cross-fertilization.

AUG. F. FOERSTE.

(WITH PLATE VIII.)

Silene Pennsylvanica is proterandrous; the shorter stamens alternating with the petals maturing first, then the longer stamens. After the anthers are effete the styles separate, become hairy along one side and are ready for pollen. The cup beneath the ovary formed by the top of the anthophore forms a nectary, from which the honey may flow at times into the calyx tube below; owing to the length of this tube the flower would seem more adapted to fertilization by butterflies, but bees were most frequently observed. The crimson corolla turns bluish purple at the crown teeth as soon as the styles become effete, a sign for insect visits to cease.

Silene regia has scarlet flowers; the change of color in the crown is far less marked. The stamens are all inclined to one side, the other side giving easy access to the nectary. The tips of the styles turn around into a loose coil, leaving the stigmatic portion on the outside of the coil directed slightly upwards, as though to insure more ready contact with the same on the part of visiting insects.

Sabbatia angularis secures the same effect by a moderate twisting of the stigma lobes, which causes the stigmatic surface to form a spiral about the lobes. In the stamens, also, the anthers, erect at first, become coiled at maturity, the coiling keeping pace with the dehiscence, which begins at the top, the top of the coil always keeping a fresh surface of the pollen exposed.

Psoralea Onobrychis has blue-purple flowers, with a greenish tinge on the center of the standard; length 4 or 5 mm.; visited by smaller-sized bees. The petals of the keel are not joined to one another, but are attached to the wings, being depressed with the same when bearing the weight of visiting insect, and at such times leaving the stamens and style exposed above the keel. Upon the pressure being released, the keel again springs up into its place.

Desmodium canescens has purplish-lilac flowers, with two whitish spots at the base of the standard, surrounded by a ring of dark purple, and serving as a guide to the opening of the flower beneath. The fact that the tenth stamen is free is *a priori* evidence of the existence of honey. The two petals composing the keel are each notched toward their base in such a manner as to leave a short projection on the outer side of the same. These projections fit into a groove in the lower part of the standard. When thus fitted the keel lies in tension, being held together around the stamens as long as the projections are held together in the groove of the standard. When a bee alights on the flower it thrusts its sucking tube beneath the standard, and in so doing spreads the keel apart, frees the projections of the keel from the grooves in the standard, and, with a quick jerk, keel and attached wings fly downward, leaving stamens and stigma in contact with the body of the intruder. The parts do not return to their former position, but change rapidly to a bluish tinge, indicating that the flowers are empty.

Lespedeza violacea has almost sessile, green, inconspicuous or minute cleistogamous flowers, chiefly in the lower axils, which do not expand, are fertilized in the bud, and are the chief flowers to produce seed. Conspicuous blue-purple flowers from the upper axils bear seed occasionally, and are adapted to cross-fertilization. The keel and wings when depressed generally take their former positions again as in *Psoralea*, but often they do not, thus leaving the stamens and stigma exposed. The bearing of cleistogamous flowers has made accurate action of the keel less necessary.

Tecoma radicans does not occur wild except within the range of Trochilus colubris, our common humming-bird. The frequent visits of this bird to the flowers of the trumpet creeper are well known, and, indeed, it seems to be the only visitor welcomed. The corolla is 7 or 8 cm. long, 2 cm. across at the throat, narrowing to 3 mm. along the lower 2 cm. of its length. Bees crawling in find the tube too narrow below. None but the largest moths have probosces long enough, and for those that have the position of the flowers seems not to be favorable. The stamens are didynamous, both pairs lying near the roof of the corolla tube, stamens of the same pair uniting slightly at their tips, the anthers being directed downward, exposing the pollen. The style extends above and beyond them, the stigmas lying anterior to the longest stamens. The flower being synacmic, cross-fertilization is secured by the sensitiveness of the stigma lobes, these closing in 7 to 10 seconds in young flowers on being disturbed. Older flowers often require 30 or 40 seconds, even more, such slow action being manifestly insufficient. But rapidity is apt then to be no longer necessary, the pistil usually being already fertilized.

Mimulus alatus has a similar arrangement of stamens and style, but the flowers being synacmic, the stigma lobes often in contact with the style, insect visits infrequent, cross-fertilization is not insured. The length of the tube makes the honey inaccessible to smaller bees. The flowers are violet-purple in color, with two hairy ridges on the lower lip, separated by a groove leading to the proper entrance. In albino flowers the entrance is darker, tinged with purple.

Mimulus ringens is essentially the same.

Scrophularia nodosa is proterogynous, as is well known. In the bud both stamens and style lie along the lower side of the corolla, curving upward anteriorly. On development the style first moves forward in position, and after fertilization continues in the same direction until it laps over the lip below. The stamens then take up the same motion. This simplicity of motion is in marked contrast to the advancing and retreating motion of stamens and styles in most Labiatæ.

Ruellia strepens has blue-purple flowers 3 cm. long, contracted rapidly below, the lower half being so narrow as to shut out all insects having sucking organs less than 13 mm. in length. The honey is secreted from a gland at the base of the ovary. The didynamous stamens are scarcely exceeded in length by the style, whose stigma is unequally lobed, the lower lobe being down-curved and often coming in contact with the upper anthers. The corolla has stripes of darker purple leading into the tube, serving as guide marks. The corolla lasts for only one day, easily falling off if disturbed. There is no structure insuring cross-fertilization.

Pycnanthemum lanceolatum has dense clusters of small white flowers, spotted with purple. Although labiate, the effect is rather that of a four-lobed corolla; the moderately didynamous stamens seem placed at the four sinuses of the same, and the style has a nearly central position. The stamens mature first, and may still contain pollen when the stigmas become receptive, although as a rule they grow effete at an earlier date. While the proterandry is not well marked, and its honey but poorly defended from general depredations, the plant is remarkable among our common Labiatæ for the great variety of insect visitors, as indeed its open structure might suggest. The most frequent visitors among these are various bees, wasps, flies, and unknown dipterous insects. Although bees visit this plant and Scrophularia nodosa alike, I could rarely succeed during the same trip in winning them from one plant to the other by holding it in their path, although there was no trouble in winning them over to plants of the same species.

Monarda fistulosa in the bud has stamens and style erect, the latter seeming the longer, but being soon overtopped by the stamens, which mature first. As they grow effete, the style ascends, surpasses the stamens in length, spreads out the lobes, and is ready in its turn. Bees, in visiting the flowers, come in contact with the anthers and stigmas chiefly on leaving the plant, rarely touching the same while gathering the honey.

Brunella vulgaris has flowers whose upper lip is violet, and the remainder white. The anthers mature first; later the stigmas open so as to stand just above and a little behind the anthers. The sterile tooth seems intended to keep the anthers forward away from the stigma; in the lower pair, where this is not necessary, the size of the teeth is much diminished. A bee entering the corolla touches the anthers first, pushing them back, and receiving fresh pollen. At the same time the stigma is being brought in contact with the old pollen as the bee presses it on its way in. So a somewhat similar result to that produced by different times of development is secured. The upper pair of anthers, at first close together, separate later, as if to avoid contact with the stigmas. Various gradations to flowers fertilizing themselves in the bud occur, in some of which the corolla never opens.

Stachys cordata in the bud has style and filaments curved forward beneath the lower lip. The stigmas are already separated, but not matured. When the flower opens the outer stamens stand before the inner ones, and the style lies behind them all. When the outer stamens have shed their pollen they move backward under the upper lip, and the inner stamens move forward to shed their pollen in turn. These also take their position under the upper lip, and the style takes their place. The stigma lobes have now separated more and are mature. The stamens, as seen, take up their position under the upper lip when effete, and do not move outward as recorded in S. palustris. The stamens have but one motion, *i. e.*, backward. When the outer stamens move backward, the upper lip does so likewise, and this makes it appear as though the inner stamens moved forward a little. Bees fertilize the flower.

EXPLANATION OF PLATE VIII.—1. *Psoralea Onobrychis; a, b,* anterior and lateral view; *c*, a lateral view, the petals of one side being removed; *d*, a petal of the keel and one of the wings attached.

2. *Lespedeza violacea; a, b,* anterior and lateral views; *c*, the andrœcium with the tip of the style projecting.

3. *Desmodium canescens; a, b,* anterior and lateral views; *c*, flower with the keel sprung; *d*, andrœcium with the style projecting.

4. *Scrophularia nodosa; a, b*, horizontal and vertical sections of a bud.

5. *Mimulus alatus; a,* the flower; *b*, a vertical section; *c*, an horizontal section seen from below.

6. *Silene regia; a, b, c,* successive stages in the coiling of the styles.

7. *Monarda fistulosa; a, b,* female and male states.

8. *Pycnanthemum lanceolatum; a, b,* male and female states; *c*, lateral view of male state; *d*, vertical section of the bud.

9. *Brunella vulgaris; a,* vertical section of bud; *b*, tip of style and stamens enlarged.

10. *Tecoma radicans; a,* horizontal section seen from below; *b*, vertical section of bud.

11. *Ruellia repens; a,* vertical section of flower; *b*, the stigma.

12. *Stachys cordata;* *a*, outer stamens mature; *b, c, d*, inner stamens mature; *e, f*, style in position, stigmas mature.

13. *Brunella vulgaris;* *a*, the flower; *b*, tips of the style and stamens enlarged.

All figures are one-third larger than nature.

Cambridge, Mass.

Description of a new fossil species of the genus Chara.

F. H. KNOWLTON.

Fossils that are now known to belong to the genus Chara were described by Dufourny de Villers, under the name of Vortex, as long ago as 1785.[1] They were regarded by him as small sea-urchins. Later, in 1807, Lamarck[2] described additional forms, under the name of Gyrogonites, which he regarded as minute univalve molluscs. This view obtained quite wide acceptance, and occurs in conchological works of the period,[3] and it was not until 1810 that Léman[4] first recognized and pointed out their true nature. Since that time upward of forty species have been recognized by paleobotanists, mostly from European localities. The only American species, so far as I can learn, is the doubtful *Chara (?) glomerata* described by Lesquereux[5] from the Green River group at Florissant, Colorado. As this species is founded upon leaf impressions, it lacks the precision which characterizes these species established upon the sporostegia or "fruits," as they are universally called by paleobotanists. These fruits are not absent from American deposits, as I am informed by Dr. C. A. White, of the United States Geological Survey, who has collected or observed them at various localities in the western territories; but they have generally been overlooked or neglected by collectors. I describe below a species which appears to be new.

Chara compressa n. sp. (figs. 1, 2).

Fruit (sporostegium) longitudinally much depressed, the height nearly one-fifth less than the width; apex obtuse or even slightly depressed; number of spirals, as observed in side view, ten.

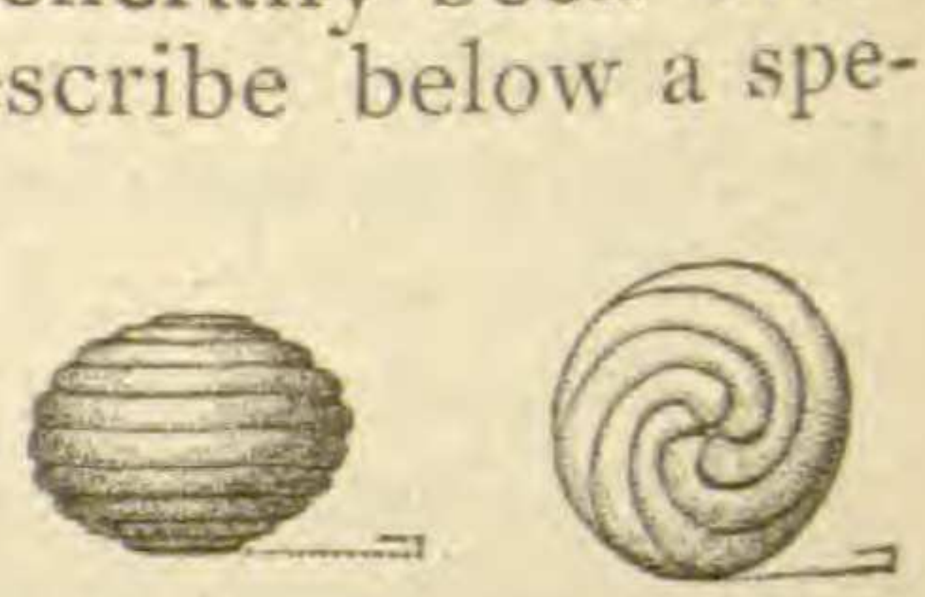

Fig. 1. Fig. 2.

CHARA COMPRESSA, n. sp.

[1] Mem. l'Acad. Jun. 1785.
[2] Ann. d. Mus. d'hist. nat. vol. ix, 1807, p. 236, pl. xvii, fig. 7.
[3] Denys de Montfort. Conchylologie systematique.
[4] Ann. d. Mus. d'hist, nat. vol. xv, 1810, pl. 23. fig. 12.
[5] Cretaceous and Tertiary Floras, 1883, p. 135. pl. xxi. fig. 12.